Nature fights back

In thinking about the state of the global environment, or of humankind's faltering efforts to preserve it, I experience occasional bouts of optimism — typically buoyed by some new technology or the enthusiasm of youthful activists. These are then punctuated by episodes of gloom brought on by facts about current reality. The news on the state of nature isn't all negative. A lot of it is.

Last year, the insurance giant Swiss Re released a report (*Biodiversity and Ecosystem Services*; Swiss Re Institute, 2020) assessing the state of the global environment. Analysing measures for water and soil quality, biodiversity, and many other factors, it concluded that roughly one nation in five faces the threat of near-future ecosystem collapse, which would erase more than 50% of their economic activity, and destroy much of their capacity to recover. In the past two decades, globally, we've lost some 500 million acres of forest.

Any naturalist or environmentalist regards such news as a profound tragedy, quite apart from any reckoning of the utilitarian or economic value lost to humanity. One can value the inherent beauty in nature — as Fiona Reynolds has argued in her moving book *The Fight for Beauty* (Oneworld Books, 2017) — even if this conception has temporarily lost favour in our contemporary economics-oriented society.

We should remember, however, just how short-sighted the degradation of nature is even from a strictly selfish human point of view, as we risk wasting an immense storehouse of scientific information and value. If this isn't obvious, the past 18 months of the COVID-19 pandemic offer several poignant reminders.

The most accurate of the many tests for the coronavirus infection — so-called PCR tests — work by detecting fragments of the virus's genetic material. These tests, familiar to anyone carrying out crucial public health tasks or still engaged in international travel, rely on an unusual enzyme discovered in a bacterium, *Thermus aquaticus*, which thrives in temperatures of 170 °F or more. That enzyme -— the Taq polymerase — underlies the polymerase chain reaction (PCR), a technique that allows scientists to amplify one tiny fragment of DNA into many identical copies.

This peculiar enzyme enables the DNA analysis behind forensic criminology, DNA tests for tracing human ancestry and innumerable techniques for diagnosing and treating diseases. None of this

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would exist if not for a weird bacterium originally discovered in the steamy geysers of Yellowstone National Park in the United States.

Likewise, the impressive success so far of the many COVID-19 vaccines isn't just due to the vision of government agencies, or the sheer brilliance of biologists and pharmaceutical researchers. It also depends on an ingredient provided by nature — specifically, unique substances found in the inner bark of the Chilean soapbark tree. These so-called saponins seem to trigger an early alert in so-called dendritic cells of our immune system, which capture antigens and present them to T cells. The process somehow ramps up the body's response to pathogens.

Most of what we read about vaccines considers their targeting measures, such as genetic sequences designed to mimic the coronavirus spike protein, yet the full process by which vaccines work is far more complex. Roughly 40% of all vaccines need these saponins — products of nature alone — to work successfully.

Hence, it's not only scientific research we can thank for the vaccines that have helped stem the spread of the virus so far in many nations, but also millions of years of biological evolution, which discovered these unique molecules. Fortunately, we haven't already wiped out the trees producing them.

Beyond the pandemic, this story repeats itself — nature as a precious resource we destroy at our own peril. Among the most pressing environmental issues we currently face is plastics pollution, which is likely to get worse before it gets better. Plastic microparticles have been found in essentially every environment in Earth, from the deepest regions of the seas to Mt Everest, and on and in the bodies of most animals and insects. Once in the environment, plastic stays around for hundreds of years. A recent study (L. Li et al. *Nature Sustainability* **3**, 929–937; 2020) found that plants may be able to take up plastics from polluted soils, bringing plastics into our food.

Yet one of the most promising ways to start reducing plastics pollution lies in recycling technologies based around chemistry inspired by biology. Some bacteria have evolved an enzyme that lets them digest cutin, the waxy substance that makes plant leaves waterproof. This enzyme, it turns out, also catalyses the breakdown of plastic — in particular, the plastic (polyethylene terephthalate, PET) used ubiquitously in packaging. A study from earlier this year found a way to engineer an improved version of an enzyme that outperforms all known PET digestive enzymes by a long margin (V. Tournier et al. *Nature* **580**, 216–219; 2021).

This is another example of why it makes good sense to preserve nature and the technological clues it holds. Of course, these examples could be multiplied. We have little idea of how many other miraculous molecules, processes, films and materials nature has already created, all far beyond our current technology. I suspect our imagination probably errs conservatively, vastly underestimating the richness of what's around us.

We have history, after all. Many leading physicists thought we'd discovered most of the fundamental laws of physics by 1900 — just before we learned about relativity, quantum theory and the expanding Universe. A few decades ago, most biologists were convinced we had a generally complete understanding of heredity and development: we knew about genes, and their dominant influence through the so-called central dogma of molecular biology, according to which genetic information in the DNA alone dictates protein structures and gene regulation through transcription and translation. Yet an extremely diverse range of epigenetic influences — including RNA interference, gene silencing and DNA methylation, all then unimagined — have proven absolutely essential to basic processes of biological function.

This is one thing we really should learn — the world always reveals itself to be richer and more complex than we had once expected. ❐

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